CLAIMS

What is claimed is

1. A block-constrained (BC)-Trellis coded quantization (TCQ) method comprising:

constraining a number of initial states of Trellis paths available for selection, in a Trellis structure having a total of N ($N=2^v$, here v denotes the number of binary state variables in an encoder finite state machine) states, within 2^k ($0 \le k \le v$) of the total N states, and constraining the number of N states of a last stage within 2^{v-k} among the total of N states dependent on the initial states of Trellis paths;

after referring to the initial states of N survivor paths determined under the initial state constraint from a first stage to a stage $L\text{-}\log_2 N$ (here, L denotes the number of the entire stages and N denotes the number of entire Trellis states), considering Trellis paths in which an allowed state of the last stage is selected among 2^{v-k} states determined by each initial state under the constraint on the state of a last stage by the constraining in remaining v stages; and

obtaining an optimum Trellis path among the considered Trellis paths and transmitting the optimum Trellis path.

2. A line spectral frequency (LSF) coefficient quantization method in a speech coding system comprising:

removing a direct current (DC) component in an input LSF coefficient vector;

generating a first prediction error vector by performing inter-frame and intra-frame prediction for the LSF coefficient vector, in which the DC component is removed , quantizing the first prediction error vector by using BC-TCQ algorithm, and then, by performing intra-frame and inter-frame prediction compensation, generating a quantized first LSF coefficient vector;

generating a second prediction error vector by performing intra-frame prediction for the LSF coefficient vector, in which the DC component is removed, quantizing the second prediction error vector by using the BC-TCQ algorithm, and then, by performing intra-frame prediction compensation, generating a quantized second LSF coefficient vector; and

selectively outputting a vector having a shorter Euclidian distance to the input LSF coefficient vector between the generated quantized first and second LSF coefficient vectors.

3. The LSF coefficient quantization method of claim 2, further comprising:

obtaining a finally quantized LSF coefficient vector by adding the DC component of the LSF coefficient vector to the quantized LSF coefficient vector selectively output.

4. The LSF coefficient quantization method of claim 2, wherein in the generating of the quantized first LSF coefficient vector, the inter-frame prediction is performed by moving average (MA) filtering and the intra-frame prediction is performed by auto-regressive (AR) filtering.

5. The LSF coefficient quantization method of claim 2, wherein in the generating of the quantized second LSF coefficient vector, the intra-frame prediction is performed by AR filtering.

6. The LSF coefficient quantization method of claim 2, wherein in a Trellis structure having a total of N ($N=2^v$, here v denotes the number of binary state variables in an encoder finite state machine) states, the BC-TCQ algorithm constrains a number of initial states of Trellis paths available for selection, within 2^k ($0 \le k \le v$) of the total of N states, and constrains a number of states of a last stage within 2^{v-k} among the total of N states dependent on the initial states of Trellis paths.

7. The LSF coefficient quantization method of claim 6, wherein the BC-TCQ algorithm refers to initial states of N survivor paths determined under the initial state constraint by the constraining from a first stage to stage $L\text{-}\log_2 N$ (here, L denotes the number of the entire stages and N denotes the number of entire Trellis states), and then, in the remaining v stages, considers Trellis paths in which the state of a last stage is selected among 2^{v-k} states determined by each initial state under the constraint on the state of a last stage, obtains an optimum Trellis path among the considered Trellis paths, and transmits the optimum Trellis path.

8. An LSF coefficient quantization apparatus in a speech coding system comprising:

a first subtracter removing a DC component in an input LSF coefficient vector and providing the LSF coefficient vector, in which the DC component is removed;

a memory-based Trellis coded quantization unit generating a first prediction error vector by performing inter-frame and intra-frame prediction for the LSF coefficient vector provided by the first subtracter, in which the DC component is removed, quantizing the first prediction error vector using a BC-TCQ algorithm, and by performing intra-frame and inter-frame prediction compensation, generating a quantized first LSF coefficient vector;

a non-memory Trellis coded quantization unit generating a second prediction error vector by performing intra-frame prediction for the LSF coefficient vector, in which the DC component is removed, quantizing the second prediction error vector by using the BC-TCQ algorithm, and by performing intra-frame prediction compensation, generating a quantized second LSF coefficient vector; and

a switching unit selectively outputting a vector having a shorter Euclidian distance to the input LSF coefficient vector between the quantized first and second LSF coefficient vectors provided by the memory-based Trellis coded quantization unit and the non-memory-based Trellis coded quantization unit, respectively.

9. The LSF coefficient quantization apparatus of claim 8, wherein the memory-based Trellis coded quantization unit comprises:

a first predictor generating a first prediction value by MA filtering obtained from a sum of quantized and prediction-compensated prediction error vectors of previous frames;

a second subtracter obtaining the prediction error vector of a current frame by subtracting the first prediction value provided by the first predictor from the LSF coefficient vector, in which the DC component is removed;

a second predictor generating a second prediction value by AR filtering obtained from multiplication of the prediction factor of i-th element value by (i-1)-th element value quantized by the BC-TCQ algorithm and then intra-frame prediction compensated;

a third subtracter obtaining the prediction error vector of i-th element value by subtracting the second prediction value provided by the second predictor from i-th element value of the prediction error vector of the current frame provided by the second subtracter;

a first BC-TCQ obtaining the quantized prediction error vector of i-th element value by quantizing the prediction error vector of i-th element value provided by the third subtracter according to the BC-TCQ algorithm; and

a first prediction compensation unit performing inter-frame prediction compensation by adding the second prediction value of the second predictor to the quantized prediction error vector of i-th element value provided by the first BC-TCQ and adding the first prediction value of the first predictor to the addition result.

10. The LSF coefficient quantization apparatus of claim 8, wherein the non-memory Trellis coded quantization unit comprises:

a third predictor generating a third prediction value by AR filtering obtained from multiplication of the prediction factor of i-th element value by the intra-frame prediction error vector of (i-1)-th element value quantized by the BC-TCQ algorithm and then intra-frame prediction compensated;

a fourth subtracter obtaining the prediction error vector of i-th element value by subtracting the third prediction value provided by the third predictor from the LSF coefficient vector of i-th element value of the LSF coefficient vector, in which the DC component is removed, provided by the first subtracter;

a second BC-TCQ obtaining the quantized prediction error vector of i-th element value by quantizing the prediction error vector of i-th element value provided by the fourth subtracter according to the BC-TCQ algorithm; and

a second prediction compensation unit performing intra-frame prediction compensation for the quantized prediction error vector of i-th element value, by adding the third prediction value of the third predictor to the quantized prediction error vector of i-th element value provided by the second BC-TCQ.

11. The LSF coefficient quantization apparatus of claim 8, further comprising:

an adder obtaining a final quantized LSF coefficient vector by adding the DC component of the LSF coefficient vector to the quantized LSF coefficient vector selectively output from the switching unit.

12. The LSF coefficient quantization apparatus of claim 9, wherein the memory-based Trellis coded quantization unit further comprises:

an adder obtaining a quantized first LSF coefficient vector by adding the DC component of the LSF coefficient vector to the quantized LSF coefficient vector selectively output from the first prediction compensation unit.

13. The LSF coefficient quantization apparatus of claim 10, wherein the non-memory Trellis coded quantization unit further comprises:

an adder obtaining a quantized second LSF coefficient vector by adding the DC component of the LSF coefficient vector to the quantized LSF coefficient vector selectively output from the second prediction compensation unit.

14. The LSF coefficient quantization apparatus of claim 8, wherein in a Trellis structure having a total of N ($N=2^v$, here v denotes the number of binary state variables in an encoder finite state machine) states, the BC-TCQ algorithm constrains a number of initial states of Trellis paths available for selection, within 2^k ($0 \le k \le v$) of the total of N states, and constrains the number of states of a last stage within 2^{v-k} among the total of N states dependent on the number of initial states of Trellis paths.

15. The LSF coefficient quantization apparatus of claim 14, wherein the BC-TCQ algorithm obtains N survivor paths by constraining a number of the states from a first stage to a stage $L\text{-}\log_2 N$ (here, L denotes the number of the entire stages and N denotes the number of entire Trellis states), and then, in remaining v stages, considers Trellis paths among the constrained number of states of the last stage, obtains an optimum Trellis path among the considered Trellis paths, and transmits the optimum Trellis path.

16. A computer readable recording medium encoded with processing instructions for performing a method of block-constrained (BC)-Trellis coded quantization (TCQ) performed by a computer, the method comprising:

constraining a number of initial states of Trellis paths available for selection, in a Trellis structure having a total of N ($N=2^v$, here v denotes the number of binary state variables in an encoder finite state machine) states, within 2^k ($0 \le k \le v$) of the total N states, and constraining the number of N states of a last stage within 2^{v-k} among the total of N states dependent on the initial states of Trellis paths;

after referring to the initial states of N survivor paths determined under the initial state constraint from a first stage to a stage $L\text{-}\log_2 N$ (here, L denotes the number of the entire stages and N denotes the number of entire Trellis states), considering Trellis paths in which an allowed state of the last stage is selected among 2^{v-k} states determined by each initial state under the constraint on the state of a last stage by the constraining in remaining v stages; and

obtaining an optimum Trellis path among the considered Trellis paths and transmitting the optimum Trellis path.

17. The recording medium of claim 16, wherein the medium is one of a magnetic storage medium, an optical readable medium and a carrier wave.

18. A computer readable recording medium. encoded with processing instructions for performing a method of line spectral frequency (LSF) coefficient quantization in a speech coding system, the method comprising:

removing a direct current (DC) component in an input LSF coefficient vector;

generating a first prediction error vector by performing inter-frame and intra-frame prediction for the LSF coefficient vector, in which the DC component is removed , quantizing the first prediction error vector by using BC-TCQ algorithm, and then, by performing intra-frame and inter-frame prediction compensation, generating a quantized first LSF coefficient vector;

generating a second prediction error vector by performing intra-frame prediction for the LSF coefficient vector, in which the DC component is removed, quantizing the second prediction error vector by using the BC-TCQ algorithm, and then, by performing intra-frame prediction compensation, generating a quantized second LSF coefficient vector; and

selectively outputting a vector having a shorter Euclidian distance to the input LSF coefficient vector between the generated quantized first and second LSF coefficient vectors.

19. The recording medium of claim 18, wherein the medium is one of a magnetic storage medium, an optical readable medium and a carrier wave.

20. A quantization method in a speech coding system comprising:

quantizing a first prediction vector obtained by inter-frame and intra-frame prediction using an input LSF coefficient vector, and a second prediction error vector obtained in intra-frame prediction, using a block-constrained (BC)-Trellis coded quantization (TCQ) algorithm, reducing memory size required for quantization and computation amount in a codebook search process.

21. The method of claim 20, wherein when data analyzed in units of frames is transmitted using the Trellis coded quantization (TCQ) algorithm additional transmission bits for initial states are not needed, reducing computational complexity.